THE ASSOCIATION FOR
DRESSINGS
&SAUCES

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June 27, 2000

Dockets Management Branch (HFA-305)
Food and Drug Administration
5630 Fishers Lane, Room 1061
Rockville, Maryland 20852

RE: Docket No. 00N-1246; Agency Information Collection Activities; Proposed Collection; Comment Request; Food Safety Survey

The Association for Dressings and Sauces (ADS) appreciates the opportunity to provide input regarding the Food and Drug Administration's (FDA) intent to conduct a voluntary consumer survey about food safety, as requested in the May 2 *Federal Register* (*FR*) notice (65 *FR* 25491). ADS applauds FDA's efforts to learn more about consumers' food safety awareness, knowledge, concerns and practices. We were recently told by FDA staff that the upcoming survey includes information on mayonnaise. As the international trade association representing manufacturers of salad dressing, mayonnaise, dressings for salads and condiment sauces and the suppliers to the industry, ADS works diligently to educate the public on the safety of commercial mayonnaise, dressings and sauces, and the Association wants to ensure the safety of commercial mayonnaise is accurately represented in the upcoming survey.

The *FR* notice indicates the majority of questions to be asked in the upcoming survey are identical to ones asked in the 1998 survey entitled, "Survey of Consumer Food Handling Practices and Awareness of Microbiological Hazards." We reviewed the 1998 survey and believe some of the potential responses to questions in the document are misleading regarding the safety of commercial mayonnaise. The specific responses of concern are detailed below.

In Section A "Risk Perception," Question A6b (version 1) of the 1998 survey, the interviewer is to ask the respondent "What kinds of foods do you consider high risk for food poisoning?" If the respondent does not identify any foods, the interviewer is to ask the following: "Can you think of any particular kinds of meat, poultry, fish or shellfish, vegetables, fruits, dairy products or prepared foods that you consider high risk for food poisoning?" The phrase "Mayonnaise or salads made with mayonnaise" is listed prominently as a potential response under "Salads" (number 17). Similarly, in Section C "Microorganisms," Question C1a1, the interviewer is to ask, "Do you remember what kinds of food you heard were related to *Salmonella* problems?" Again, mayonnaise and

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salads containing mayonnaise are listed as potential responses (number 17). We are greatly concerned with the possible inclusion of this language in the forthcoming survey because it perpetuates what we call the "mayo myth."

The myth about mayonnaise safety stems from the fact that many years ago, it was not unusual for dressings, mayonnaise in particular, to be prepared from scratch. When making mayonnaise, home cooks used unpasteurized eggs which scientists now know can sometimes be contaminated with bacteria. Homemade mayonnaise also may not contain the perfect blend of vinegar and salt to counteract the growth of harmful bacteria.

Commercial mayonnaise does not have the food safety risks of its homemade ancestor. The safety of commercially prepared mayonnaise and salad dressing has been documented over the past 60 years by the FDA, the U.S. Department of Agriculture and countless other food science and health organizations. In fact, these commercial products are carefully prepared under strict quality controls and contain pasteurized eggs that have been heat treated to destroy harmful bacteria and ensure product safety. Additional ingredients such as vinegar and lemon juice create a high-acid environment that slows and even inhibits microbial growth. Salt is also an important ingredient that contributes to the unfavorable environment for bacteria. In fact, according to Dr. Michael Doyle, Professor and Director of the University of Georgia's Center for Food Safety and Quality Enhancement, "Commercial mayonnaise is among the safest of foods when properly handled. Most harmful bacteria die off within hours in the presence of mayonnaise, largely due to its acidity."

We would appreciate your assistance in accurately representing any information regarding the safety of commercial mayonnaise to be contained in the upcoming survey. Toward that end, we urge that the "Mayonnaise or salads made with mayonnaise" language not be included in the potential responses in the upcoming survey because we believe it is misleading. However, if the Agency decides to keep the reference to mayonnaise, we strongly suggest the language in the potential responses be revised as follows:

> "**Homemade** mayonnaise **made with raw eggs** or salads made with **such homemade** mayonnaise"

The bolded additions make the potential food safety concern more clear and fully differentiate between homemade products and their microbiologically safe commercial counterparts. FDA made this distinction in its earlier survey as evident by questions J4 and J5 (version 1) and J4 (version 2).

In reality, it is the unsanitary handling and preparation of foods in home kitchens and foodservice operations that pose the greatest threat of bacterial contamination in foods. Many of the foods typically used with mayonnaise, such a chicken, ham or potatoes, are

much more susceptible to bacterial growth than the mayonnaise itself. Proper precaution in handling these foods should be followed during the preparation and in storage of the sandwich or salad. We have enclosed the summary of the decades of research confirming the safety of commercially prepared mayonnaise, dressings and sauces. Additional information can be found on our Web site at www.dressings-sauces.org.

Any efforts to learn more about consumers' food safety awareness, knowledge, concerns and practices are to be commended as such information will help us all in our role as food safety educators. However, the information must be accurately represented so the results are meaningful and no myths are perpetuated. If you have any questions regarding dressing and sauce products, now or in the future, please feel free to use ADS as a resource. I can be reached at 404/252-3663, 404/252-0774 (fax) or pchumley@ assnhq.com (e-mail).

Sincerely,

Pamela A Chumley

Pamela A. Chumley
Executive Director

PAC/jcm

Enclosure

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Mayonnaise and Food Safety:

Facts about the Safety Commercial Mayonnaise and Salad Dressing Products

Commercial mayonnaise and salad dressing products are safe. However, despite a large body of evidence to the contrary, there persists a belief among many American consumers that mayonnaise is a major cause of food poisoning. For more than 50 years, members of the scientific and regulatory communities have conducted research and published articles that document the safety of commercially prepared mayonnaise and salad dressing. Time and time again, the popular condiment has been exonerated by leading authorities on food safety. Yet, the American public refuses to give up the myth about mayonnaise and foodborne illness.

Indeed, commercial mayonnaise and spoonable salad dressings are carefully formulated with highly acidic ingredients and pasteurized eggs under rigorous quality control procedures making these products extremely unlikely sources for bacteria that cause food poisoning. Acidulents, such as vinegar, lemon juice and salt, provide flavor and an unfriendly environment in which harmful bacteria cannot grow. Furthermore, there is evidence that the high-acid environment of commercial mayonnaise will actually kill bacteria. Eggs used in regular commercial mayonnaise and mayonnaise-type salad dressings must meet certain quality standards including pasteurization treatments to assure microbiological safety.

Where did the "mayo myth" begin?

Unsafe homemade mayonnaise recipes gave birth to the myth that mayonnaise causes food poisoning. Homemade mayonnaise recipes almost always call for raw eggs. But, scientists now

know that uncooked shell eggs can sometimes be contaminated by *salmonella* bacteria. Furthermore, salt and acid levels often vary greatly in recipes for homemade mayonnaise. Today, food communicators rarely suggest the use of homemade mayonnaise and if a recipe is offered, raw eggs have been omitted.

Now, it is unsafe food handling and preparation in home kitchens and foodservice operations that pose a greater threat of bacterial contamination of food.

Many low-acid foods, like chicken, ham or potatoes, are susceptible to the growth of bacteria and are often mixed with mayonnaise. Mishandled, these foods can create a favorable medium for food contamination. There are many potential sources of bacterial contamination in the on-site preparation of "homemade" recipes, including the various ingredients of these recipes and other foods and surfaces in the kitchen that could serve to cross-contaminate. It is for this reason that the use of commercially prepared mayonnaise and dressing is encouraged for restaurant and home use. However, no amount of mayonnaise in a salad can counteract ALL the problems that may result from poor sanitary conditions.

Now, virulent strains of new food bacteria, such as *E. coli* O157:H7, threaten the world food supply confounding health officials and food industry. Outbreaks of *E. coli* over the last five years implicated a number of foods, including mayonnaise and salad dressing. In its commitment to continue manufacturing safe, wholesome products, the mayonnaise and dressing industry, through The Association for Dressings and Sauces, sponsored research which was recently published and once again verified the safety of mayonnaise prepared with good manufacturing practices.

However, the study did point to the importance of safe food handling revealing that *E. coli* O157:H7 can survive several weeks in even commercial mayonnaise once cross-contaminated by foods such as raw beef, unclean utensils, or *E. coli* O157:H7-infected food handlers. Good sanitation practices will greatly minimize the possibility of cross-contaminating mayonnaise and other foods with *E. coli* and other foodborne bacteria.

The Association for Dressings and Sauces is an international association of manufacturers of dressings for salads, mayonnaise, mustard and specialty sauces and their suppliers.

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Research Abstracts

Documenting the Effect of Acid Medium of Mayonnaise and Salad Dressing on Significant Microorganisms

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Erickson, John P., Stamer, Joseph W., Hayes, Maranda, McKenna, Denise N and Van Alstine, Leslie A., 1995. An Assessment of *Escherichia coli* O157:H7 Contamination Risks in Commercial Mayonnaise from Pasteurized Eggs and Environmental Sources, and Behavior in Low-pH Dressings. Journal of Food Protection, Vol. 58, (10), pgs. 1059-1064

Summary:

"An enterohemorrhagic *Escherichia coli* O157:H7 (EHEC) outbreak in 1993 was epidemiologically linked to commercial real mayonnaise. This study evaluated EHEC contamination risk during commercial mayonnaise and mayonnaise dressing production, and EHEC behavior in low-pH dressings. Two potential contamination sources, pasteurized liquid eggs and wet environmental areas, were surveyed for 4 months in three processing plants. One hundred eighty-eight egg lots and 114 environmental swabs were collected and analyzed for EHEC by enrichment and direct plating methods. All plant samples were EHEC negative. Commercial mayonnaise plants which use pasteurized eggs and employ effective good manufacturing practices (GMP) sanitation programs are unlikely EHEC harborage and contamination sources. Five commercial real-mayonnaise-based and reduced-calorie and/or fat mayonnaise dressings were inoculated with ≥ 6 $\log_{10}$ colony-forming units (CFU)/g EHEC contamination levels and stored at 25°C. The products contained a wide range of acetic acid, NaCl, and preservative levels, while pH varied from 3.21 to 3.94. Products below pH 3.6 rapidly inactivated EHEC, producing ≥ 7 $\log_{10}$ CFU/g decreases in ≤ 1 to ≤ 3 days. High EHEC lethality was also observed in the pH 3.94, egg white-mayonnaise dressing. Intact packages of commercial mayonnaise and mayonnaise dressings pose negligible EHEC contamination and health hazard risks. As with any food, consumers and food-service workers must use stringent hygienic practices to prevent microbial pathogen contamination during preparation, handling, and storage of mayonnaise-ingredient recipes such as chilled perishable salads and salad bar dressings."

Hathcox, Alan K., Beauchat, Larry R. and Doyle, Michael P., 1995. Death of Enterohemorrhagic *Escherichia coli* O157:H7 in Real Mayonnaise and Reduced-Calorie Mayonnaise Dressing as Influenced by Initial Population and Storage Temperature. Applied and Environmental Microbiology, Vol. 61, No. 12, pgs. 4172-4177

Summary:

"This study was undertaken to determine the survivability of low-density populations (10^0 and 10^2 CFU/g) of enterohemorrhagic *Escherichia coli O*157:H7 inoculated into real mayonnaise and reduced-calorie mayonnaise dressing and stored at 20 and 30° C, temperatures within the range used for normal commercial mayonnaise distribution and storage. Inactivation patterns at 5° C and inactivation of high-inoculum populations (10^6 CFU/g) were also determined. The pathogen did not grow in either mayonnaise formulation, regardless of the inoculum level or storage temperature. Increases in storage temperature for 5 to 20° C and from 20 to 30° C resulted in dramatic increases in the rate of inactivation. Population of *E. Coli* O157:H7 in the reduced-calorie and real formulations inoculated with a population of 0.23 to 0.29 $\log_{10}$ CFU/g and held at 30° C were reduced to undetectable levels within 1 and 2 days, respectively; viable cells were not detected after 1 day at 20° C. In mayonnaise containing an initial population of 2.23 $\log_{10}$ CFU/g, viable cells were not detected after 4 days at 30° C or 7 days at 20° C; tolerance was greater in real mayonnaise than in reduced-calorie mayonnaise dressing stored at 5° C. The tolerance of *E. Coli* O157:H7 inoculated at the highest population density (6.23 $\log_{10}$ CFU/g) was less in reduced-calorie mayonnaise dressing than in real mayonnaise at all storage temperatures. In reduced-calorie mayonnaise dressing and real mayonnaise initially containing 2.23 $\log_{10}$ CFU/g, levels were undetectable after 28 and 58 days at 5° C , respectively. While *E. Coli* O157:H7 was inoculated at a population of 6.23 $\log_{10}$ CFU/g, it was not detected in reduced calorie-mayonnaise dressing held at 5° C after 58 days and was approaching undetectable levels in real mayonnaise after 93 days. The pathogen clearly does not survive in real mayonnaise or reduced-calorie mayonnaise dressing commercially prepared with good manufacturing practices, and the rate of inactivation is most rapid at temperatures at which commercially processed mayonnaise is distributed and stored."

Lock, J.L. and Board, R.,G., 1994. The fate of *Salmonella enteriditis* PT4 in deliberately infected commercial mayonnaise. Food Microbiology 11, pgs. 499-504

Summary:

"A total of 30 samples (24 different varieties) of commercial mayonnaise deliberately inoculated with *Salmonella enteritidis* PT4 have been studied. The fastest death rate of the test organism was obtained with a fat-free mayonnaise pH 2.6. There was a trend indicating that the antimicrobial attributes of mayonnaise were enhanced when the pH become more acid, especially with acetic acid as the acidulant. The looseness of the correlation of death rates with pH in the range 4-5 may well reflect the contribution of the diverse range of ingredients other than acids to the antimicrobial properties of this commodity. One general statement is possible, in the majority of mayonnaises *S. enteritidis* was protected to a limited extent by storage at 4°C viz à viz storage at 20°C."

Raghubeer, Errol V., Ke, Jim S., Campbell, Michael L., and Meyer, Richard S., 1994. Fate of *Escherichia coli* O157:H7 and Other Coliforms in Commercial Mayonnaise and Refrigerated Salad Dressing. Journal of Food Protection, Vol. 58, pgs. 13-18

Summary:

"Commercial mayonnaise and refrigerated ranch salad dressing were inoculated at two levels with two strains of *Escherichia coli* O157:H7, a non-pathogenic *E. coli*, and the non-fecal coliform *Enterobacter aerogenes*. Results showed that at the high inoculation level (>10^6 colony forming units [CFU]/g) in mayonnaise stored at room temperature (ca. 22° C) both strains of O157:H7 were undetected at 96 h. At the high inoculation level, all strains of coliform bacteria tested survived longer in salad dressing stored at 4°C than in mayonnaise stored at 22°C. The O157:H7 strains were still present at low levels after 17 days. The survival time in the low-level inoculum (10^4 CFU/g) study decreased, but the survival pattern in the two products was similar to that observed in the high-level inoculum study. Slight differences in survival among strains were observed. The greater antimicrobial effect of mayonnaise may be attributable to differences in pH, water activity (a_w), nutrients, storage temperature, and the presence of lysozyme in the whole eggs used in the production of commercial mayonnaise. Coliform bacteria survived longer in refrigerated salad dressing than in mayonnaise particularly at the high-level inoculum. Both mayonnaise (pH 3.91) and salad dressing (pH 4.51) did not support the growth of any of the microorganisms even though survival was observed."

Erickson, John P., McKenna, Denise N., Woodruff, Marie A. and Bloom, Jill S., 1993. Fate of *Salmonella* spp., *Listeria monocytogenes*, and Indigenous Spoilage Microorganisms in Home-style Salads Prepared with Commercial Real Mayonnaise or Reduced Calorie Mayonnaise Dressings. Journal of Food Protection, Vol. 56, No. 12, pgs. 1015-1021.

Summary:

"Two home-style salads, chicken and macaroni, were prepared with three different commercial mayonnaise products: (i) real mayonnaise, (ii) reduced calorie mayonnaise dressing, and (iii) reduced calorie/reduced fat mayonnaise dressing. The salads were inoculated with 10^3/ml levels of *Salmonella* spp. or *Listeria monocytogenes* and held at 4°C (refrigeration) and 12.8°C (temperature abuse) for 10 and 2 d, respectively. Uninoculated controls were evaluated to determine the refrigerated shelf-life limit and microbial spoilage profile of both salads. *Salmonella* spp. growth occurred in the temperature-abused chicken salad, while *L. monocytogenes* grew in the temperature-abused and refrigerated chicken salad. The synergistic combination of mayonnaise and refrigeration inhibited *L. monocytogenes* outgrowth for >7 d. The microbiological shelf life of refrigerated chicken and pasta salads was 5 and 7 d, respectively. Microbial spoilage was predominantly caused by heterofermentative lactic acid bacteria, of which *Leuconostoc mesenteroides* was the most important. The organism was psychotropic and exhibited competitive inhibition against *Salmonella* spp. The latter was attributed to diacetyl formation synergistically interacting with the acidic salad environment. No microbiological safety or spoilage differences were observed between the salads prepared with real mayonnaise or reduced calorie mayonnaise dressings. Under proper refrigeration and good hygienic practices, home-style salads made with commercial real mayonnaise/mayonnaise dressings represent negligible microbial health hazard risks to consumers."

Radford, S.A, Tassou, C.C., Nychas, G.J.E. and Board, R.G., 1991. The influence of different oils on the death rate of *Salmonella enteritidis* in homemade mayonnaise. Letters in Applied Microbiology 12, pgs. 125-128

Summary:

"The death rate of *Salmonella enteritidis* was always faster in mayonnaise made with extra virgin olive oil than in that prepared from blended olive or sunflower oils. The acidity and the phenolic profiles of these oils differed significantly. The most acidic oils (0.5% oleic acid), the extra virgin oils, also had the most complex phenolic profiles. The acidity of sunflower and blended olive oil was 0.2% and 0.4% respectively.

Mayonnaise, an oil-in-water emulsion, is made from vegetable oils, egg yolk, water, vinegar and/or lemon juice, sodium chloride and, depending upon recipe, sweeteners,

spices or sodium glutamate (Smittle 1977). Mayonnaise and related products are unlikely to transmit food-poisoning bacteria because of their low pH values, of about 4.1 (Collins 1985). Wethington & Fabian (1950) and Perales & Garcia (1990) showed that the numbers of salmonellas and staphylococci diminished rapidly at values below 4.1, the duration of the survival period being determined by the concentration of acetic or citric acid. Low temperature, and low a_w values in mayonnaises may inhibit foodborne pathogens (Smittle 1977). Products containing less than normal amounts of acid have been associated with foodborne outbreaks of salmonellosis and *Staphylococcus aureus* (Collins 1985; Mitchell *et al.* 1989; Gomez-Lucia *et al.* 1990; Perales & Garcia 1990).

Commercial edible oils differ in their acidity (Kiritsakis 1988) but, according to Washington & Fabian (1950), such differences are unlikely to effect appreciably the microbial stability of mayonnaise. The present paper provides evidence that different grades of oil do influence the death rate of salmonellas in mayonnaise."

Glass Kathleen A. and Doyle, Michael P., 1991. Fate of *Salmonella* and *Listeria monocytogenes* in Commercial, Reduced-Calorie Mayonnaise. Journal of Food Protection, Vol. 54, No. 9, pgs. 691-695

Summary:

"Two new varieties of commercial low-calorie mayonnaise, i.e., cholesterol-free, reduced-calorie (CFM) and reduced-calorie (RCM), made with different levels of acetic acid, were evaluated to determine the survival characteristics of *Salmonella* or *Listeria monocytogenes*. Two formulations of CFM, made with 0.3 or 0.7% acetic acid in the aqueous phase, and four formulations of RCM, made with 0.1, 0.3, 0.5, or 0.7% acetic acid in the aqueous phase, were evaluated. The initial pH of the products after equilibration ranged from 3.9 to 4.3, which was adjusted by addition of HCl. Products were inoculated with an eight- or six-strain mixture of *Salmonella* sp. or *L. monocytogenes*, respectively, at ca. 10^6 CFU per gram and held at 23.9° C for up to 2 weeks. *L. monocytogenes* survived longer than *Salmonella* in equivalent preparations of mayonnaise. No *Salmonella* (per 100 g) was detected at 48 h in either variety of mayonnaise made with 0.7% acetic acid in the aqueous phase. *Salmonella* levels in mayonnaise made with lower levels of acetic acid decreased during storage, and at 2 weeks the organism was not detectable in samples containing 0.3% acetic acid in the aqueous phase. No *L. monocytogenes* (per 100g) was detected at 14 or 10 d postinoculation in CFM or RCM, respectively, made with 0.7% acetic acid in the aqueous phase. Results indicated these new varieties of mayonnaise, when formulated with 0.7% acetic acid in the aqueous phase, will inactivate > 10^7 Salmonella and > 10^4 *L. monocytogenes* per gram within the 72-h holding time required for regular mayonnaise made with unpasteurized eggs. Hence, properly acidified (pH <4.1) reduced-calorie mayonnaise containing 0.7% acetic acid in the aqueous phase is a microbiologically safe product."

Erickson, P. John and Jenkins, Phyllis, 1991. Comparative *Salmonella* Spp. and *Listeria monocytogenes* Inactivation Rates in Four Commercial Mayonnaise Products. Journal of Food Protection, Vol. 54, No. 12, pgs. 913-916

Summary:

"*Salmonella* spp. and *Listeria monocytogenes* strains were inoculated into four commercial mayonnaise products: sandwich spread, real mayonnaise, reduced calorie mayonnaise dressing, and cholesterol-free reduced calorie mayonnaise dressing. Products represented a broad cross-section of aqueous phase acetic acid, salt, sucrose, and other compositional factors. Results showed that *Salmonella* spp. inactivation rates were unaffected by formula composition. The organism was rapidly inactivated, decreasing ≥ 8 $\log_{10}$ CFU/g in ≤ 72 h, in each of the four products. *L. monocytogenes* inactivation rates were directly correlated with aqueous phase acetic acid concentrations as follows: sandwich spread > real mayonnaise > cholesterol-free reduced calorie mayonnaise dressing > reduced calorie mayonnaise dressing. *L. monocytogenes* inactivation rate in sandwich spread and real mayonnaise was similar to *Salmonella* spp. The reduced calorie mayonnaise dressings showed gradual, incremental population declines. *L. monocytogenes* decreased 3 and 5 $\log_{10}$ CFU/g in 72 h in reduced calorie and cholesterol-free reduced calorie mayonnaise dressings, respectively. The higher anti-listerial activity in the cholesterol free formulation was attributed to egg white lysozyme. This study documented that commercial mayonnaise, including reduced calorie mayonnaise dressing varieties, represent negligible consumer safety risks."

Perales, I. and García, M.I. 1990. The influence of pH and temperature on the behavior of *Salmonella enteriditis* phage type 4 in home-made mayonnaise. Letters in Applied Microbiology 10, pgs. 19-22

Summary:

"The behavior of *Salmonella enteritidis* phage type 4 in home-made mayonnaise was studied. Samples of mayonnaise were prepared with different pH values using wine vinegar or lemon juice in order to bring down the pH to 5, 4·5, 4 and 3·6, inoculated an incubated at 4, 24 and 35° C for 5 days. The results showed a better bactericidal activity of the vinegar (acetic acid) than the lemon juice (citric acid), both of these acids being more active at higher temperatures. For preventing salmonellosis transmission by home-made mayonnaise the use of vinegar as an acidulant in order to achieve a pH between 3.6 and 4 and storage in a warm place is recommended.

Most of the outbreaks of foodborne diseases that occur in Spain are transmitted through home-made mayonnaise made from fresh eggs, with *Salmonella enteritidis*

being the main cause (Perales *et al.* 1989) and a relatively high percentage of eggs being contaminated with *Salmonella* (Perales & Audicana 1989). This bacterium can be detected inside fresh intact eggs probably as a consequence of contamination before laying (Perales & Audicana 1989; Sesma *et al.* 1987).

The situation is not exclusive to Spain. Very recently in the northeastern USA and the UK the increase of *Salmonella. enteritidis* infections was associated with eggs or egg-containing foods, raising the possibility of transovarian contamination of eggs with *Salmonella. enteritidis* (Anon. 1988; St. Louis *et al.* 1988).

The fact that whole fresh eggs can contain *Salmonella* prompted us to begin a study of the culinary habits used in making mayonnaise in restaurants. With the data obtained we carried out a study in order to determine the conditions in which *Salmonella. enteritidis* could be destroyed depending on the pH, the nature of the acid used and the time and temperature of storage."

Miller, Mary L., Martin, Eric D. 1990. Fate of Salmonella enteritidis and Salmonella typhimurium Inoculated Into An Italian Salad Dressing with Added Eggs. Dairy Food and Environmental Sanitation. 10:(1)12-14. Orlando, Florida.

Summary:

"The addition of *Salmonella* to an oil and vinegar based Italian salad dressing was evaluated using *S. Enteritidis* and *S. Typhimurium.* Both a direct plating method and a lactose broth preenrichment method were used to determine survival times of the added inoculum. The initial inoculum of approximately 5 million Salmonella organisms per gallon of dressing dropped to an unrecoverable level following 5 minutes mixing and 5 minutes holding for the *S. Typhimurium.*

Collins, M.A. 1985. Effect of pH and Acidulant Type on the Survival of Some Food Poisoning Bacteria in Mayonnaise. Microbiologie - Aliments - Nutrition. 1985, Vol. 3, 215-221.

Summary:

"The survival of *Salmonella muenster, Staphylococcus aureus* and *Clostridium perfringens* in mayonnaise containing either acetic or citric acid as acidulant was investigated over a range of pH values. In addition, as *C. perfringens* sporulated so poorly that statistically meaningful data could not be obtained, spores of the related *Clostridium sporgenes* were used to study the survival of bacterial endospores in mayonnaise. All vegetative bacterial cells were eliminated in acetic acid mayonnaise pH<4.4 *S. aureus* was not eliminated from citric acid mayonnaise, in addition, at pH>5.0 both *S. muenster* and *C. perfringens* survived in this product. However,

Closteridial spore numbers were virtually unaffected by any treatment. Increasing the pH and the use of citric acid to reduce the sharpness of taste inherent in acetic acid mayonnaise would not appear to give a microbiologically safe product whereas the use of acetic acid in mayonnaise at pH<4.2 should prevent survival of vegetative cells of these food poisoning bacteria in this product although spores could persist."

Committee on Food Protection; Food and Nutrition Board, National Research Council. 1985. An Evaluation of the Role of Microbiological Criteria for Foods and Food Ingredients. National Academy Press. Washington, D.C. 278.

Summary:

"The safety of these products relates directly to the pH (4.1 or below) and the acetic acid content (approximately 0.3-1.2%) of the moisture phase. Egg is the sensitive ingredient in mayonnaise and salad dressings because of the potential for Salmonella contamination from this source. However, salmonellae, if present, in properly prepared products die in a matter of days due to the low pH and the acetic acid content. Also, growth of *Clostridium botulinum, Clostridium perfringens, Bacillus cereus,* and *Staphylococcus aureus* is prevented. Thus the hazard presented by properly prepared products is remote."

Morita, T.N. and Woodburn, M. 1983. Enterotoxin C_2 Production by S. Aureus in Entree Salads. Oregon State University, Corvallis, Oregon, Journal of Food Science. 48:243.

Summary:

" ...Staphylococcal food poisoning remains one of the leading causes of foodborne illness (Center for Disease Control, 1978) and the largest number of cases reported was due to consumption of different types of salads. ...This study was initiated to study the potential for support of staphylococcal enterotoxin production of both plant and animal protein sources at the pH of entree salads.

Mayonnaise and salad dressings retard spoilage and growth of pathogens due to their high concentration of acetic acid. ...Although salad dressings themselves do not support the growth of staphylococi, when they are mixed with low-acid ingredient in entree salads, including those without meat or poultry but the potato, soy, or macaroni, *S. Aureus* was able to multiply and produce enterotoxin at 37°C."

Doyle, M.P., Foster, D.M. 1982. Fate of Salmonella typhimurium and Staphylococcus aureus in Meat Salads Prepared With Mayonnaise. The Food Research Institute. Journal of Food Protection. 45 (2):152.

Summary:

"Increasing the concentration of mayonnaise in salads increased the degree to which growth of these organisms was delayed. Contrary to popular belief, the presence of mayonnaise in meat salads tends to retard rather than enhance growth of food-borne pathogens. However, addition of mayonnaise should not be considered a substitute for refrigeration for preserving meat salads from the growth of food-borne pathogens."

Swaminathan, B., Howe, J.M., and Essling. C.M. 1981. Mayonnaise, Sandwiches and Salmonella. Journal of Food Protection. 44 (2):115.

Summary:

"Mayonnaise is often listed as one of the major culprits in bacterial foodborne diseases. However, the high acid content of commercial mayonnaise in the U.S. suggests an improbability of growth of food poisoning organisms in salad dressings and sandwiches. In this study, sandwiches prepared with home-cooked or commercially purchased turkey meat and made with or without commercially available mayonnaise, were inoculated ... Mayonnaise had significantly inhibitory effect on growth of *Salmonella typhimurium* in sandwiches prepared with turkey breast meat...."

Industry Testing. 1965. Effect of Various pH and Acidity Levels on Destruction of Salmonellae in Salad Dressings held at 45°F. And 72°F. (Unpublished).

Summary:

Salmonella and other "food-poisoning' bacteria were unable to propagate in the mayonnaise or salad dressing samples used when the pH was lowered to below 4.0 and the temperature was kept at or slightly above room temperature. The key factor was always the pH level rather than the room temperature. The temperature affected the speed of the pH reaction.

Lawrence, R.L. 1965. Fate of Salmonella in Mayonnaise Held at 84°F. Bayonne Laboratories. (unpublished)

Summary:

"These results demonstrate that when typical *Salmonella*, actually isolated from contaminated salted frozen egg yolks are inoculated into a mayonnaise premix and thus made into a mayonnaise, they are readily killed (not detectable after 24 hours). Furthermore, when Salmonella contaminated frozen salted egg yolks are used to prepare a mayonnaise, they are not detectable after 2 hours at room temperature.."

Lawrence, R.L. Microbiological Examination of Mayonnaise for Presence of Salmonella. Bayonne Laboratories. 1965.

Summary:

"Results of the tests done on plant production samples as well as open-market purchases of... mayonnaise showed that in no case was there any Salmonella bacteria present after culturing on enrichment broths. Indeed, there was no growth observed on any of the selective agar plates after transferal of sample from the enrichment broths."

Klusmeyer, P.W. 1965. Salmonellae Survival in Salad Dressing and Mayonnaise, Summary. Bacteriology Department, Henningsen Foods, Central Laboratories. Springfield, Missouri (unpublished).

Summary:

"From the material in this study it would appear that there is little chance of survival of *Salmonellae* in either salad dressing or mayonnaise. This is no doubt due to the amount of acid present. Several brands of commercial salad dressing and mayonnaise were checked for acidity and pH and none approached the low acid level of our laboratory formula."

Moinick, D. 1963. The Incidence of Salmonella in Mayonnaise and Ingredients. Bayonne Laboratories (unpublished).

Summary:

"In relation to the inoculated mayonnaise, noteworthy is the rapid destruction of Salmonella after incubation. There are, however, Salmonella present after 24 hours but not after 48 hours using the pre-enrichment technique. These results show that

should mayonnaise become contaminated with Salmonella, they would be killed in a very short time."

Weiser, H.H. 1962. Organic and Inorganic Acids and Alkalies in Food Preservation. Practical Food Microbiology and Technology. AVI Publishing Co., Westport, Connecticut. (16):238.

Summary:

"Food has been preserved since early history by acids. The normal fermentation that usually takes place in food rich in carbohydrates results in the precaution of sufficient acid in the product to suppress further microbial activity."

Larch, M. 1961. The Survival of Salmonella in Mayonnaise and Meat Salads. (Translation) Institute of Hygiene, Free University, Berlin. Wiener Tierarztliche Monatsschrift. 48:348.

Summary:

"The length of time required for the destruction of salmonellae is dependent upon the pH, the number and type of organisms and the temperature of storage. The lower the pH of a mayonnaise the sooner the organisms will be killed. The pH should be below 4.0 and a value of 3.95 should be attained. If a small number of salmonellae are introduced into the mayonnaise the organisms will be destroyed with certainty within 24 hours."

Gram, H.G. 1957. Destruction of Salmonella, Staphylococcus aureus, B. Proteus, and B. Alkaligenes in Mayonnaise. (Translation). Institute of Bacteriology, Pathology and Serology. Die Fleischwirtschaft. 3:111.

Summary:

"As a result of investigations, it may be noted that mayonnaise acts like a bactericidal substance provided the acetic acid content is not markedly lower than 0.2%. This is true for enteritis causing organisms of the TPE group, for staphylococcus species, *B. Proteus, and B. Alkaligenes.* The acetic acid being included in mayonnaise is responsible for this effect. If salmonella contaminated raw materials are used in preparing mayonnaise, it may be considered as certain that there are no viable Salmonella to be found in it a few days after the mayonnaise has been prepared. Thus pasteurization of the raw egg yolk is not necessary, if it is used in preparing mayonnaise."

Wethington, M.D. and Favian, F.W. 1949. Viability of Food-poisoning Staphylococci and Salmonellae in Salad Dressing and Mayonnaise. Michigan State College. Journal. Article 1,094:125.

Summary:

"Under the conditions of these experiments the following statements appear justified: The strains of food-poisoning *Staphylococci* tested were more resistant to the conditions found in salad dressing than were the different species of *Salmonellae* tested. The one ingredient which had the greatest influence on the viability of the bacteria tested was acetic acid. Decreasing the amount of the acetic acid in either salad dressing or mayonnaise increased survival time of the organism studied. Owing to their acid content, mayonnaise and salad dressing are not probable sources of *Staphylococci* or *Salmonellae* food-poisoning."

Baker, J.H. 1942. Survival Period. Food Poisoning Bacteria in Salad Dressing and Mayonnaise. Car-Baker Laboratories. New York. (Unpublished)

Summary:

"*Salmonella paratyphi, Staphylococci* (enterotoxin strain) and *Streptococcus mitior (viridans)* are unable to propagate in the mayonnaise and salad dressing samples tested. Hugh inoculations of these samples with the various "food poisoning" bacteria showed they were destroyed, which may be due to the high acidity or low pH of the media. In all cases, 24 hours were more than sufficient to completely destroy all of the inoculum in the samples under investigation with the exception of the French Salad Dressing which required 24-48 hours to destroy *Streptococcus mitior (viridans).*"

Levine, A.S. and Fellers, C.F. 1940. Action of Acetic Acid on Food Spoilage Microorganisms. Massachusetts Agricultural Experiment Station, Amherst, Massachusetts. J. Bacteriol. 39:499.

Summary:

"The toxic effect of vinegar upon certain microorganisms is usually attributed to its acetic acid content. Acetic acid in nutrient broth inhibited the growth of various microorganisms related to food spoilage. The bacteria used did not grow in both adjusted with acetic acid to pH 4.9. *Saccharomyces cereviseae* did not grow at pH 3.9 and *Aspergillus niger* was inhibited at pH 4.1.

An increase in the hydrogen-ions resulted in a decrease of the thermal death points of the bacteria studied .... Comparative studies showed acetic acid to be more toxic than

either lactic or hydrochloric acid to *Salmonella aertycke, Saccharomyces cereviseae,* and *Aspergillus niger."*

Articles and Regulatory Documents/Statements

Testifying to the safety of commercial mayonnaise and salad dressings

Doyle, M.P. 1996. Statement by Michael P. Doyle, Ph.D., Professor and Director, University of Georgia, Center for Food Safety and Quality Enhancement.

"Commercial mayonnaise is among the safest of foods when properly handled. Most harmful bacteria die off within hours in the presence of mayonnaise, largely due to its high acidity. As with all foods, individuals handling edibles should use proper hygienic practices and good judgment in preparing and storing foods. Precautions should be taken to avoid contaminating mayonnaise with harmful bacteria through contact with potentially hazardous foods or infected human carriers."

Archer, D.C. 1989. Statement by Douglas L. Archer, Ph.D., Acting Deputy Director, Center for Food Safety and Applied Nutrition, U.S. Food and Drug Administration. (Formerly Director, FDA Division of Microbiology).

"Commercial mayonnaise and other commercial dressings are prepared under strict quality controls, and acidulents and salt are added at levels that prevent the growth of food poisoning bacteria. In fact, hazardous bacteria die off if placed in the commercially-prepared product. After its container is opened, commercial mayonnaise may lose certain appearance and quality attributes if not refrigerated. Commercial mayonnaise is frequently mixed, as a dressing, with other foods which do support the growth of hazardous bacteria. Thus, the refrigeration of such mixed foods is prudent. The United States Department of Agriculture's *Safe Food Book* (Home and Garden Bulletin #241) correctly states that 'mayo (real, commercially prepared) is not a villain!' As the book further states correctly that 'adding mayonnaise (re., commercially prepared) to food slightly increases that food's resistance to food poisoning.'

Homemade mayonnaise is not subject to the same rigorous quality controls as its commercially-prepared counterpart. The composition of homemade mayonnaise, including the salt and acid levels, may vary greatly. Homemade mayonnaise should be carefully prepared and stored in the refrigerator."

United States Department of Agriculture. USDA News Division. Washington, D.C. Office of Information. August 11, 1983.

Summary:

"It's wrong to blame the mayonnaise," says Stanley Green, a microbiologist with the U.S. Department of Agriculture's Food Safety and Inspection Service. Research now shows that mayonnaise doesn't cause these incidents." Actually, adding mayonnaise to meat, chicken, fish, potato and similar salads slows the growth of most food poisoning bacteria," Green Said. "Why" Because mayonnaise is slightly acid, and food poisoning bacteria can't grow in that environment. And mayo's twin, salad dressing' contains even more lemon juice, making it even more unfriendly to bacteria."

Foster, D.E. 1979. Does Mayonnaise Increase the Risk of Food Poisoning? Food Research Institute, University of Wisconsin - Madison. (Unpublished)

Summary:

"For maximum safety mayonnaise should be added to sandwiches and salads as early as possible, not held separate until the very last minute. Mayonnaise will actually help prevent the growth of food poisoning bacteria.

Mayonnaise is an effective bacterial growth inhibitor because of its acid content. Food poisoning bacteria can grow in a normal mixture of food and mayonnaise, but their rate of growth depends on the amount of mayonnaise present as well as the temperature and composition of the food. Mayonnaise does not take the place of proper food handling procedures.

So if you are concerned about food poisoning, don't spare the mayo. The sooner it is added and the more that it is used, the safer the food will be.

Code of Federal Regulations, Title 21. 1995. Part 101.100(d)(3).

Summary:

Dressings are recognized as a safe and suitable bactericidal process for the destruction of Salmonella in egg products in lieu of pasteurization. The Code of Federal Regulations states:

" ...In addition to safe and suitable bactericidal processes designed specifically for Salmonella destruction in egg products, the term "other treatment" .... shall include use in acidic dressings in the processing of which the pH is not above 4.1 and the acidity of the aqueous phase, expressed as acetic acid, is not less than 1.4 percent, subject also to (certain) conditions ...."

Smittle, R.B. 1977. Microbiology of Mayonnaise and Salad Dressing: A Review. Journal of Food Protection. 40(6):415.

Summary:

"Mayonnaise and salad dressing commercially produced in the United States are defined in accordance with the Food and Drug Administration Standard of Identity. The microbiological content of these products is dictated primarily by the high acetic acid concentration found in their aqueous phase. The overall microbiological content of mayonnaise and salad dressing is low with a very low incidence of spoilage. Lactobacilli, yeasts, and bacilli are the organisms commonly found. The organisms most frequently isolated from spoiled products are yeast and, to a lesser extent, lactobacilli. The major preservative effect is from the acetic acid content with a minor influence from salt or sugar concentration. Mayonnaise and salad dressing produced in the United States are inimical to bacteria, especially food pathogens. The acetic acid levels used by the major producers, 0.31-0.32% for mayonnaise and 0.90-0.928% for salad dressing, are effective in destroying salmonellae and staphylococci. Salad dressing and mayonnaise used to prepare salads and sandwiches have an inhibitory effect on pathogenic bacterial growth in these products, which is attributed to the acetic acid from the mayonnaise and salad dressing. Contrary to popular opinion, mayonnaise and salad dressing when added to salads or sandwiches will not increase spoilage or public health hazards, but actually retard spoilage and growth of pathogenic microorganisms."

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